Amendments to the Specification

On page 8, lines 1-27, replace with the following:

Figure 2A illustrates a schematic diagram of a hermetically sealed closed loop cooling system 30 which includes the microchannel heat exchanger 100 of the present invention. In addition, Figure 2B illustrates a schematic diagram of an alternative hermetically sealed closed loop cooling system 30' which includes the microchannel heat exchanger 100' with multiple ports ~~108, 109~~ 108', 109' coupled to multiple pumps 32' and a diverting valve 33'. The diverting valve 33' and multiple pumps 32' supply more than one fluid stream to the heat exchanger 100'. It should be noted that the system 30, 30' alternatively incorporates additional components not shown in the figures and is not limited to the configuration shown.

As shown in Figure 2A, the fluid ports 108, 109 are coupled to fluid lines 38 which are coupled to a pump 32 and a heat condensor 30. The pump 32 pumps and circulates fluid within the closed loop 30. In one embodiment, a uniform, constant amount of fluid flow enters and exits the heat exchanger 100 via the respective fluid ports ~~108', 109'~~ 108, 109. Alternatively, variable amounts of fluid flow enter and exit through the inlet and outlet port(s) ~~108, 109~~ 108', 109 of the heat exchanger 100' at a given time. Alternatively, as shown in Figure 2B, two or more pumps 32' provide fluid to several designated inlet ports ~~108~~ 108' via one or more valves 33'. It will be apparent that the architectures shown in Figures 2A and 2B are representative only. Any number of pumps and fluid ports can be provided.

As shown in Figures 2A-2B, one or more sensors 130, 130' are coupled to the heat exchanger 100, 100' and/or heat source 99, 99', whereby the sensors 130, 130' provide information of the operating conditions in the heat exchanger 100, 100 to a dynamic sensing and control module 34, 34'. The control module 34, 34' is coupled to the pumps 32, 32' and/or heat exchanger 100, 100' and dynamically controls the amount and flow rate of fluid entering and exiting the heat exchanger 100, 100' in response to information received from the one or more sensors 130, 130' regarding changes in heat, hot spot locations, flow rates, fluid temperatures, pressure of the fluid and general operation of the system 30, 30'. For instance, the control module ~~34~~ 34' initiates operation of both pumps 32' in response to an increase in the amount of heat in a hot spot location. It should be noted that the sensing and control module 34, 34' is applicable to both cooling systems, as shown in Figures 2A-2B.

On page 10, lines 1-13, replace with the following:

Figure 3B illustrates a perspective view of the of the interface layer ~~302~~ 102' having several different heat transferring features disposed along the interface layer in accordance with the present invention. The interface layer 102' includes multiple microchannels 109, wherein two of the microchannels are of the same shape and one microchannel 111 has a portion extending taller than the other portion. In addition, the interface layer 102' includes several pillars 132, 134 of various height dimensions disposed thereon in accordance with the present invention. As shown in Figure 3B, the pillars 134 extend vertically from the bottom surface of the interface layer ~~302~~ 102 to a predetermined height, potentially the entire height of the interface layer 102'. The pillars 132 extend vertically an amount less than the pillars 134. The pillars 134 can have any shape including, but not limited to, squared (Figure 3B), diamond (not shown), elliptical (not shown), hexagonal (not shown), circular or any other shape. The interface layer alternatively has a combination of differently shaped pillars disposed thereupon. In addition, Figure 3B illustrates a microporous structure 136 disposed on the bottom surface of the interface layer 102'.

On page 11, lines 16 to page 12, line 4, replace with the following:

For instance, as shown in Figure 3D, the interface layer ~~102"~~ 102"' includes several sets of rectangular fins ~~136~~ 138"' which are radially disposed with respect to one another in their respective set. In addition, the interface layer ~~302~~ 102"' includes several pillars ~~134~~ 134"' disposed between the sets of rectangular fins ~~136~~ 138"'. It is apparent that the interface layer 102 can include one type of heat transferring feature or alternatively any combination of different heat transferring features (e.g. microchannels, pillars, micro-porous structures).

The interface layer 102 preferably has a high thermal conductivity which minimizes the temperature differences between the heat source 99 and the fluid flowing along the interface layer ~~302~~ 102. The interface layer is preferably made from a material having a high thermal conductivity of 100 W/m-K. The heat transferring features preferably have thermal conductivity characteristics of at least 10 W/m-K. However, it is apparent to one skilled in the art that the interface layer 102 and heat transferring features have a thermal conductivity of more or less than the preferred amount and is not limited thereto. More details regarding the interface layer as well as the heat transferring features are discussed in co-pending patent application Serial No. Cool-01301, filed on October 6, 2003, and entitled "METHOD AND APPARATUS FOR EFFICIENT VERTICAL FLUID DELIVERY FOR COOLING A HEAT PRODUCING DEVICE", which is hereby incorporated by reference.

On page 12, line 18 to page 13, line 3, replace with the following:

As shown in Figure 4A, fluid initially enters the heat exchanger 100 through one inlet port 108, although more than one inlet port 108 is contemplated. The fluid then flows to an inlet channel 116. Alternatively, the heat exchanger 100 includes more than one inlet channel 116. As shown in Figures 4A and 4B, fluid flowing along the inlet channel 116 from the inlet port 108 initially branches out to finger 118D. In addition, the fluid which continues along the rest of the inlet channel 116 flows to individual fingers 118B and 118C and so on. In the example, fluid is supplied to interface hot spot region A by flowing to the finger 118A, whereby fluid flows down in the Z-direction through finger 118A to the intermediate layer 104. The fluid then flows through an inlet conduit 105A in the ~~interface~~ intermediate layer 104 which is positioned below the finger 118A, to the interface layer 102. The fluid preferably travels along the microchannels 110 as shown in Figure ~~4B~~ 4A and undergoes thermal exchange with the heat source 99'. The heated liquid then travels upward in the Z-direction through the conduit 105B to the outlet finger 120A.

On page 14, line 6 to page 16, line 14, replace with the following:

As shown in Figure 5, the fluid enters the heat exchanger 200 via fluid ports 208A and is directed to interface hot spot region A by flowing along the intermediate layer 204A to the inflow conduits 205A. The fluid then flows down the inflow conduits 205A in the Z-direction into the interface hot spot region A of the interface layer ~~202~~ 202A. The fluid flows in between the microchannels 210A whereby heat from location A' transfers to the fluid by conduction through the interface layer ~~202~~ 202A. The heated fluid flows along the interface layer 202 in interface hot spot region A' toward exit port 209A where the fluid exits the heat exchanger 200. It is apparent to one skilled in the art that any number of inlet ports 208 and exit ports 209 are utilized for a particular interface hot spot region or a set of interface hot spot regions.

Similarly, the heat source 99" in Figure 5 has a warm spot in location B' which produces less heat than location A'. Fluid entering through the port 208B is directed to interface hot spot region B' by flowing along the intermediate layer 204B to the inflow conduits 205B. The fluid then flows down the inflow conduits 205B in the Z-direction into interface hot spot region B of the interface layer ~~202~~ 202B. The fluid flows and is channeled along the microchannels ~~210~~ 210B, whereby heat generated by the heat source in location B' is transferred to the fluid. The heated fluid flows along the entire interface layer 202B in interface hot spot region ~~B'~~ B and

upward to exit ports 209B in the Z-direction via the outflow conduits 205B in the intermediate layer ~~204~~ 204B. The fluid then exits the heat exchanger 200 through the exit ports 209B.

In one embodiment, the heat exchanger 200 is coupled to one pump 32 as shown in the closed loop system 30 (Figure 2A). In another embodiment, the heat exchanger 200 is coupled to more than one pump 32', whereby a set of input ports 208A and output ports 209A are coupled to one pump (pump 1) whereas another set of input ports 208B and output ports 209B are coupled to another pump ~~32~~ (pump 2). Alternatively, the valve 33' (Figure 2B) can direct a different amount of flow to port 208A and 208B.

The heat exchanger 200 is designed in one embodiment to keep a desired fraction of the flow separate such that fluid from one pump does not mix with fluid from another pump. Thus, there is more than one independent fluid loop circulating within the heat exchanger 200. In particular, the heat exchanger 200 in Figure 5 has an independent fluid loop to interface hot spot region ~~A'~~ A and another independent fluid loop to interface hot spot region ~~B'~~ B. As discussed in more detail below, the independent loops in the heat exchanger 200 are used to achieve temperature uniformity and effectively cool the hot spots in the heat source 99". The independent fluid loops can be used to supply a consistent amount of fluid to one or more interface hot spot region as well as the remaining portion of the interface layer.

Figure 6 illustrates an exploded view of another embodiment of the heat exchanger 300 ~~embodiment~~ in accordance with the present invention. The manifold layer 306 shown in Figure 6 includes three individual levels. In particular, the manifold layer 306 includes a circulation level 304, an inlet level 308 and an outlet level 312. Alternatively, the circulation level 304 is not utilized, whereby the interface layer 302 is coupled directly to the inlet level 308. As shown by the arrows in Figures 6, cooled fluid enters the heat exchanger 300 through the inlet port 315 in the outlet level 312. The cooled fluid travels down the inlet port 315 to the inlet port 314 in the inlet level 308. The fluid then flows into the corridor 320 and flows downward in the Z-direction to the interface layer 302 via the inlet apertures 322 in the circulation level 304. However, the cooled fluid in the inlet corridor 320 does not mix or come into contact with any heated fluid exiting the heat exchanger 300. The fluid entering the interface layer 302 undergoes thermal exchange with the solid material and absorbs the heat produced in the heat source 99. The inlet apertures 322 and outlet apertures 324 are arranged such that the fluid travels the optimal closest distance along the interface layer 302 from each inlet aperture 322 to an adjacent outlet aperture 324. The optimal distance between the inlet and outlet apertures reduces the pressure drop therebetween while effectively cooling the heat source 99. The heated fluid then

travels upward in the Z-direction from the interface layer 302 through the inlet level 308 via the several outlet apertures 324 to the outlet corridor 328 in the outlet level 312. Alternatively, the heated fluid travels upward in the Z-direction from the interface layer 302 directly to the outlet corridor 328 in the outlet level 312. The heated fluid, upon entering the outlet corridor 328 in the outlet level 312 flows to the outlet port 316 and exits the heat exchanger 300. The heated fluid does not mix or come into contact with any cooled fluid entering the manifold layer 306 as it exits the heat exchanger 300. It is apparent that the fluid flow shown by the arrows in Figure 6 is alternatively reversed.

Figure 7A illustrates a perspective view of another embodiment of the heat exchanger 400 in accordance with the present invention. The manifold layer 406 in Figure 7A includes a plurality of interwoven or inter-digitated parallel fluid fingers 411, 412 which allow one phase and/or two-phase fluid to circulate to the interface layer 402 without allowing a substantial pressure drop from occurring within the heat exchanger 400 and the system 30, 30' (Figures 2A-2B). In one embodiment, the inlet fingers 411 are arranged alternately with the outlet fingers 412 in the heat exchanger 400.